SYSTEM AND METHOD FOR RADAR DETECTION AND CALIBRATION

Field of the Invention

The present invention generally relates to a system and method for radar detection and calibration, and more
5   particularly a radar detection and calibration system and method utilizing an unmanned air vehicle (UAV) as a calibration target.

Background of the Invention

10   The performance of a radar system can be affected by atmospheric conditions, thereby providing erroneous information that can result in undesirable and even severe consequences. Atmospheric conditions and radar mechanical and electrical conditions can significantly reduce the radar's
15   detection range such that the detection range is expected to be much greater than its true range given existing atmospheric conditions and radar condition. By way of example, a radar normally having a detection range of 100 miles may under particular atmospheric conditions have an actual range of 90
20   miles. Using a military application as an example, a radar used to detect enemy aircraft may, because of existing atmospheric conditions and radar condition, actually see a target at significantly less than the expected range,

resulting in less time being available to deploy defense systems or even gaps in detection coverage of a system of radars. To avoid such overestimates of actual radar performance, it has been known to use manned test aircraft to

5   determine the true detection range. The manned test aircraft were flown between non-detection and detection zones, and by knowing the aircraft's actual position the radar's true detection range could be determined.

However, the use of manned test aircraft for this purpose

10   is expensive and poses a safety risk to the pilot. Moreover, because they must be of a sufficient size to be manned, they are limited in their use as radar detection and calibration targets where small radar cross-sections are desired or required.

15   Summary of the Invention

The present invention solves these problems, providing a system and method for radar detection and calibration that accounts for existing atmospheric conditions and radar condition without the need to use manned aircraft. Generally,

20   in accordance with one aspect of the present invention a relatively small and inexpensive UAV is used to provide such detection and calibration, which may also include signal augmentation to simulate the radar cross-section of larger targets.

25   More specifically, the detection and calibration system generally comprises a calibration target and a calibration device. In accordance with a preferred embodiment of the invention, the calibration target comprises a UAV, a position device and a signal augmentation device. The position device

30   is adapted to determine an actual position of the UAV at a given time, and the signal augmentation device is adapted to

augment the radar cross-section of the target. The calibration device is in communication with the calibration target and a radar system, and is adapted to receive actual position parameter signals from the calibration target

5 defining the actual position of the calibration target and sensed position parameter signals from the radar system defining the sensed position of the calibration target. A radar system error for calibrating the radar system may be determined from the actual and sensed position signals.

10   Further generally in accordance with the invention, the detection and calibration system and method are adapted to determine the true detection range of the radar system under existing atmospheric conditions and actual radar condition by controlling the flight of an UAV between non-detection and

15 detection zones, monitoring the sensed and actual positions of the UAV, and detecting the radar's true range based upon the UAV's actual position relative to the radar system when the radar system detects the UAV at the radar's maximum range.

As another aspect of the invention, a signal augmentation

20 device is provided to simulate various targets having radar cross-sections larger than the UAV used as a calibration target. The signal augmentation device generates a reflected radar signal from the UAV, the magnitude of which may be selected to simulate the radar cross-section of a target, such

25 as for example, a ship or larger aircraft, that may have a radar cross-section several orders of magnitude greater than the non-augmented radar cross-section of the UAV. Using the signal augmentation of the invention, the radar system's true radar range may be determined under existing atmospheric

30 conditions for various targets, including those having much larger radar cross-sections, without using the actual targets, which in most cases would be impractical.

Further features and advantages of the present invention, as well as the structure and operation of various embodiments of the present invention, are described in detail below with reference to the accompanying drawings.

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Brief Description Of The Drawings

Figure 1 is a block diagram of a calibration system and method according to a preferred embodiment of the present invention in communication with a radar system shown

10   schematically; and

Figure 2 is a diagram illustrating a preferred embodiment of the invention as used to detect a radar system's true radar range.

Detailed Description Of The Preferred Embodiments

15   Referring to the drawings, there is shown a preferred embodiment of a radar detection and calibration system 20 of the invention generally comprising a calibration target 22 and a calibration device 24 for calibrating a radar system 26. The radar system 26 has a detection zone 30 for a particular

20   target within which the radar system is able to detect the target. The size of the detection zone 30 is dependent upon the size of the target's radar cross-section, such that the greater the target's radar cross-section the greater the radar's detection zone for that target. The radar's non-

25   detection zone is identified as the zone 32 extending beyond the detection zone.

The calibration target 22 is preferably a UAV, such as the BOEING SCAN EAGLE™, although any suitable UAV may be used. The UAV includes a control system 40 adapted to navigate the

30   UAV, and a position device 42 adapted to provide an actual position of the UAV at any given time.

In accordance with a preferred embodiment of the invention, the calibration target 22 also includes a signal augmentation device 44 for augmenting the radar cross-section of the calibration target. The signal augmentation device 44

5   may be a mechanical reflector or more preferably may be implemented electronically. When electronically implemented, the radar signal is electronically amplified to a desired level and transmitted as the return signal which is interpreted by the radar system as a calibration target having

10 an augmented radar cross-section. The device 44 may be a suitable broadband amplifier known in the art and available from various suppliers. For example, the device 44 may be a Signal Augmentation System (SAS) by Northrop Grumman. In this described preferred embodiment, the calibration target 22 may

15 have a non-augmented radar cross-section of as little as a square meter or less which may be augmented by the augmentation device 44 to be several orders of magnitude greater, thus providing a range of available radar cross-sections that may be selected for range detection and

20 calibration and may include, but is not limited to, radar cross-sections that approximate those of manned aircraft 50 and ships 52.

The calibration device 24 is in communication with the calibration target 22 and is configured to receive signals

25 from the position device 42 defining the actual position at a given time of the calibration target 22. The calibration device 24 is also in communication with the signal augmentation device 44 and is configured to select a desired level of augmentation for the electronics of the augmentation

30 device to replicate the radar cross-sections of actual targets having greater radar cross-sections than the calibration target without augmentation. The calibration device 24 also

is in communication with the radar system 26 to receive a sensed position of the calibration target 22, and is configured to detect variances between the actual position received from the position device 42 and the sensed position

5 received from the radar system 26. The calibration device 24 may be a separate computing device or alternatively may be integral with the radar system 26, and in either case its implementation is well within the skill of those in the art. The calibration device 24 compares the detected sensed and

10 actual positions of the calibration target, and from this comparison calculates a sensing error that may be used to adjust the radar system to more accurately sense target positions within the detection zone.

In operation, the detection and calibration system and

15 method of the invention may be used to detect the true radar range of a radar system under actual operational conditions, i.e., actual atmospheric conditions and actual radar condition. A UAV is programmed to navigate in accordance with a predetermined flight plan that takes it on a course that

20 extends between a radar system's non-detection zones and detection. As the UAV flies the predetermined course, the system of the invention detects the position of the UAV upon the radar system detecting the UAV at the radar system's maximum radar range, whereby the UAV's actual position at the

25 radar system's maximum radar range is .the true radar range under existing atmospheric conditions. This same process may be repeated using the signal augmentation device 44 at various levels of radar cross-section augmentation to simulate targets of various sizes and configurations, and to determine the true

30 radar range of the radar system for such targets. These true radar range detection procedures, whereby the true radar ranges for targets of various radar cross-sections are

determined, may be carried out within a single flight or over multiple flights of the UAV.

The calibration system 20 may also be used to determine a sensing error of a radar system 26. In accordance with this

5   application, the UAV is programmed with a flight path that places the UAV in the detection zone 30 of the radar system. At a selected detection time, the position device 42 and the radar system 26 transmit signals to the calibration device 24 representing the actual and sensed positions, respectively, of

10   the UAV. The calibration device compares these signals and from the comparison reduces or eliminates the sensing error of the radar system.

Further in accordance with the invention, the UAV may also be used as a practice target for a radar system operator

15   using the radar system 26. In accordance with this application, the UAV is programmed to fly in the detection zone 30, and the radar system operator uses the radar system 26 to determine a sensed position of the UAV.

While the present invention has been described by

20   reference to specific embodiments and specific uses, it should be understood that other configurations and arrangements could be constructed, and different uses could be made, without departing from the scope of the invention as set forth in the following claims.

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